

## SECTION 16010

### BASIC ELECTRICAL REQUIREMENTS

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. This section is a Division-16 Basic Electrical Requirements section, and is part of each Division-16 section making reference to electrical related work specified herein.

##### 1.2 SUMMARY:

- A. Work consists of construction of electrical systems and components in facility, as described in Division 1, Division 13, Division 15, Division 16, other Divisions of the Specifications, and as shown on the Drawings.
- B. This Section specifies the basic requirements for electrical installations and includes requirements common to Division 16 sections. It expands and supplements the requirements specified in sections of Division 1.

##### 1.3 DEFINITIONS:

Design Professional: The Architect, Engineer, or Consultant; or Architectural firm, Engineering firm, or Consulting firm that issued the referenced Specifications or Drawings. In general, the person or firm that issued the particular section or drawing referenced in the context of the usage of the term.

##### 1.4 QUALITY ASSURANCE:

- A. Manufacturers: Firms regularly engaged in manufacture of products for electrical related work of sizes, types, ratings, and materials required, whose products have been in satisfactory use in similar service for not less than 3 years.
- B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with electrical related work similar to that required for this project.
- C. Key Employees: Supervisors, Superintendents, Master Electricians with at least 3 years of successful installation experience on projects with electrical related work similar to that required for this project. Identify and designate Key Employees selected for project and include resume and credentials with bid. Key Employees must remain part of the project. Design Professionals must approve selection of and changes in Key Employees designated for Work.

##### 1.5 ELECTRICAL INSTALLATIONS:

- A. Coordinate electrical equipment and materials installation with other building components and existing field conditions and with Architect and Engineer. Verify all dimensions by field measurements.
- B. Obtain all necessary permits, releases and other permissions necessary to begin work. Submit copies of such to Architect and Engineer.

- C. Arrange for chases, slots, and openings in other building components to allow for electrical installations.
- D. Coordinate the installation of required supporting devices and sleeves to be set in poured in place concrete and other structural components, as they are constructed.
- E. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing-in the building.
- F. Coordinate the cutting and patching of building components to accommodate the installation of electrical equipment and materials.
- G. Where mounting heights are not detailed or dimensioned, install electrical services and overhead equipment to provide the maximum headroom possible.
- H. Install electrical equipment to facilitate maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
- I. Coordinate the installation of electrical materials and equipment above ceilings with suspension system, mechanical equipment and systems, and structural components.
- J. Coordinate connection of electrical systems with exterior services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service. Notify each service or utility of commencement of work.
- K. Coordinate connection of mechanical systems with actual field conditions and products supplied.

#### 1.6 ELECTRICAL COORDINATION DRAWINGS:

- A. Prepare and submit a set of coordination drawings showing major elements, components, and systems of electrical equipment and materials in relationship with other building components.
- B. Prepare drawings to an accurate scale of 1/4"=1'-0" or larger. Indicate the locations of all equipment and materials.
- C. Prepare floor plans, reflected ceiling plans, elevations, sections, and details to conclusively coordinate and integrate all installations. Indicate locations where space is limited, and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:
  - 1. Equipment room layouts;  
coordination of requirements with Telephone Utility Company.

#### 1.7 CUTTING AND PATCHING:

- A. This Article specifies the cutting and patching of electrical equipment, components, and materials to include removal and legal disposal of selected materials, components, and equipment.
- B. Refer to the Division 1 Sections for general requirements for cutting and patching.

- C. Refer to Division 15 Sections for requirements for cutting and patching mechanical equipment, components, and materials.
- D. Do not endanger or damage installed Work through procedures and processes of cutting and patching.
- E. Arrange for repairs required to restore other work, because of damage caused as a result of electrical installations.
- F. No additional compensation will be authorized for cutting and patching Work that is necessitated by ill-timed, defective, or non-conforming installations.
- G. Perform cutting, fitting, and patching of electrical equipment and materials required to:
  1. uncover Work to provide for installation of ill-timed Work;
  2. remove and replace defective Work;
  3. remove and replace Work not conforming to requirements of the Contract Documents;
  4. remove samples of installed Work as specified for testing;
  5. upon written instructions from the Architect/Engineer, uncover and restore Work to provide for Architect/Engineer observation of concealed Work.
- H. Cut, remove and legally dispose of selected electrical equipment, components, and materials as indicated, including, but not limited to removal of electrical items indicated to be removed and items made obsolete by the new Work.

#### 1.8 SUBMITTALS:

- A. Refer to the Division 1 for basic submittal definitions, requirements, and procedures. Additional requirements and procedures are given in this section and other Division 16 sections. Design Professional may require that any Work not performed in accordance with the requirements listed herein be removed at the Contractor's expense
- B. Submittal of shop drawings, product data, and samples will be accepted only when submitted by The Contractor per instructions detailed in Division 1. Data submitted from sub-contractors and material suppliers directly to the Design Professional will not be processed. The Contractor must ensure that sub-contractors, vendors, and suppliers provide submittals in accordance with all requirements described in Division 1.
- C. SUBMIT AT LEAST ONE COPY OF EACH SUBMITTAL MADE OF ORIGINAL LITERATURE OR DRAWINGS. Additional copies may be duplicates made from originals. Multiple generation photostatic duplicates, facsimile transmissions, or other poor quality submittal materials will not be processed.
- F. Submit Coordination Drawings for approval prior to initiation of work. Do not begin work without Coordination Drawings approved by the Design Professional. Work performed prior to approval will be subject to removal (at the contractor's cost) at the discretion of the Design Professional.
- G. Submit equipment and fixture purchase releases, with related trades' work dates and schedules, to indicate proper preparation and coordination of equipment and fixture orders. Show shipping dates and arrival dates, with associated work schedules of all trades which will be affected by delivery of equipment or fixtures.

- H. Submit Utility and Service companies published requirements for general conditions and specific requirements for this project. Show confirmation of notification to Utility or Service companies of commencement of Project. Do not begin any utility related work without notification to utilities and approval of intentions from utility companies and Engineer.

1.9 PRODUCT OPTIONS AND SUBSTITUTIONS:

- A. Refer to the Instructions to Bidders and Division 1 Sections for basic requirements in selecting products and requesting substitutions. Additional requirements are given in this section and other Division 16 sections.
- B. Refer to individual sections for specific instructions regarding product selection or substitution for products, materials, or devices of those sections.
- C. Product substitutions must be submitted with material indicating compliance with specifications and comparisons of features and components of the specified products and the intended substitution. It is the responsibility of the party or parties wishing to make the substitution to show compliance with these specifications and equal or superior performance to products called for in these specifications or products indicated on the contract drawings. Substitutions made without this information may be rejected.

1.10 PRODUCT LISTING:

- A. Prepare a preliminary listing of all major electrical equipment and materials planned for the project. Include items that will require coordination with other trades, and items that have date sensitive delivery or installation. Include Utility Company items that require coordination or interaction with any Division 13, Division 15, or Division 16 Work.
- B. When two or more items of a similar nature, or of the same material or equipment, are required they shall be of the same manufacturer. Product manufacturer uniformity does not apply to raw materials, bulk materials, conduit, fittings, sheet metal, steel bar stock, welding rods, solder, fasteners, motors for dissimilar equipment units, and similar items used in Work, except as otherwise indicated.
- C. Provide products which are compatible within systems and other connected items.

1.11 NAMEPLATE DATA:

Provide permanent operational data nameplates on each item of power distribution or power operated equipment, indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data. Locate nameplates in an accessible, visible location.

1.12 DELIVERY, STORAGE, AND HANDLING:

- A. Refer to Division 1 for general requirements. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.
- B. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage.

- C. Coordinate deliveries of electrical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.

1.13 PROJECT RECORD DOCUMENTS:

- A. Refer to Division 1 sections for general requirements. The following paragraphs supplement the requirements of Division 1.
- B. Mark Drawings to indicate revisions to conduit size and location both exterior and interior; actual equipment locations, dimensioned for column lines; concealed equipment, dimensioned to column lines; distribution and branch electrical circuitry; fuse and circuit breaker size and arrangements; support and hanger details; Change Orders; concealed control system devices.
- C. Mark Specifications to indicate approved substitutions; Change Orders; actual equipment and materials used.

1.14 OPERATION AND MAINTENANCE DATA:

- A. Refer to the Division 1 Sections and other instructions from the Architect for procedures and requirements for preparation and submittal of maintenance manuals.

1.15 WARRANTIES:

- A. Refer to the Division 1 sections for procedures and submittal requirements for warranties. Refer to individual equipment specifications for warranty requirements.
- B. Compile and assemble the warranties specified in Division 1 and Division 16 sections into a separated set of vinyl covered, three ring binders, tabulated and indexed for easy reference.
- C. Provide complete warranty information for each item, product or equipment, to include date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.
- D. In addition to any warranty requirements specified in Division 1, warrant all Work for a period of at least one year from date of acceptance.

1.16 OPERATION AND MAINTENANCE:

Refer to the Division 1 and Division 16 sections for instructions concerning operation and maintenance of equipment and systems.

1.17 ROUGH-IN:

- A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
- B. Refer to equipment specifications in Divisions 2 through 15 for rough-in requirements.

1.18 CLEANING:

Refer to the Division 1 Sections for general requirements for final cleaning.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS:**

General: Provide quality products as specified in this and other Division 16 sections, and on the drawings. Provide only those products intended for the use indicated. Provide new products, purchased for use on this Project.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION:**

- A. General: Install materials in a neat, organized and timely manner. Show good workmanship and quality work.
- B. Complete Systems: PROVIDE LABOR, MATERIALS, EQUIPMENT, AND TRANSPORTATION TO RECEIVE, INSTALL, ADJUST, AND PUT INTO OPERATION COMPLETE ELECTRICAL SYSTEMS IN ACCORDANCE WITH THE INTENT OF THE CONTRACT DOCUMENTS. PROVIDE PRODUCTS NOT MENTIONED BUT OBVIOUSLY NECESSARY AND INCIDENTAL TO THE COMPLETION OF THIS WORK.

### **3.2 WRITTEN MATERIALS:**

Prepare all warranties, submittals, and instructions indicated to be prepared. Hand Deliver at least one copy of each to Owner at time of acceptance.

**END OF SECTION**

## SECTION 16050

### BASIC ELECTRICAL MATERIALS AND METHODS

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Requirements specified in Division 16 Section "Basic Electrical Requirements" apply to this Section.

##### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Raceways.
  - 2. Building wire and connectors.
  - 3. Supporting devices for electrical components.
  - 4. Electrical identification.
  - 5. Electricity-metering components.
  - 6. Concrete equipment bases.
  - 7. Electrical demolition.
  - 8. Cutting and patching for electrical construction.
  - 9. Touchup painting.

##### 1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. FMC: Flexible metal conduit.
- C. IMC: Intermediate metal conduit.
- D. LFMC: Liquid-tight flexible metal conduit.
- E. RNC: Rigid nonmetallic conduit.

##### 1.4 SUBMITTALS

- A. Product Data: For electricity-metering equipment.
- B. Shop Drawings: Dimensioned plans and sections or elevation layouts of electricity-metering equipment.
- C. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

## 1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

## 1.6 COORDINATION

- A. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.
  - 1. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.
  - 2. Set conduit below slab and in leave-outs prior to concrete work. Coordinate installation with concrete installation.
- B. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.
- C. Coordinate electrical service connections to components furnished by utility companies.
  - 1. Coordinate installation and connection of exterior underground and overhead utilities and services, including provision for electricity-metering components.
  - 2. Comply with requirements of authorities having jurisdiction and of utility company providing electrical power and other services.
- D. Coordinate location of access panels and doors for electrical items that are concealed by finished surfaces. Access doors and panels are specified in Division 8 Section "Access Doors."
- E. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.
- F. Where acoustical ceilings and similar finishes will conceal electrical identification markings and devices, coordinate installation of electrical items before ceiling installation.
- G. Coordinate the shut-off and disconnection of electrical service with the Owner and the utility company.

## PART 2 - PRODUCTS

### 2.1 CONDUCTORS

- A. Conductors, No. 10 AWG and Smaller: Solid.
- B. Conductors, Larger Than No. 10 AWG: Stranded copper.
- C. Conductors, longer than 100 feet: no less than No. 10 AWG, or as necessary to maintain a maximum voltage drop of 3% or as indicated on drawings.
- D. Insulation: Thermoplastic, rated at 75 deg C minimum.

- E. Wire Connectors and Splices: Units of size, ampacity rating, material, type, and class suitable for service indicated.

## 2.2 SUPPORTING DEVICES

- A. Material: Cold-formed steel, with corrosion-resistant coating acceptable to authorities having jurisdiction. Supports shall be designed for seismic restraint per code requirements.
- B. Metal Items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel.
- C. Slotted-Steel Channel Supports: Flange edges turned toward web, and 9/16-inch- (14-mm-) diameter slotted holes at a maximum of 2 inches (50 mm) o.c., in webs.
- D. Slotted-Steel Channel Supports: Comply with Division 5 Section "Metal Fabrications" for slotted channel framing.
  - 1. Channel Thickness: Selected to suit structural loading.
  - 2. Fittings and Accessories: Products of the same manufacturer as channel supports.
- E. Nonmetallic Channel and Angle Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- (14-mm-) diameter holes at a maximum of 8 inches (203 mm) o.c., in at least one surface.
  - 1. Fittings and Accessories: Products of the same manufacturer as channels and angles.
  - 2. Fittings and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.
- F. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring-steel clamps or click-type hangers.
- G. Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.
- H. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for non-armored electrical cables in riser conduits. Plugs have number and size of conductor gripping holes as required to suit individual risers. Body constructed of malleable-iron casting with hot-dip galvanized finish.
- I. Expansion Anchors: Carbon-steel wedge or sleeve type.
- J. Toggle Bolts: All-steel springhead type.
- K. Powder-Driven Threaded Studs: Heat-treated steel.

## 2.3 ELECTRICAL IDENTIFICATION

- A. Identification Devices: A single type of identification product for each application category. Use colors prescribed by ANSI A13.1, NFPA 70, and these Specifications.
- B. Raceway and Cable Labels: Comply with ANSI A13.1, Table 3, for minimum size of letters for legend and minimum length of color field for each raceway and cable size.
  - 1. Type: Pre-tensioned, wraparound plastic sleeves. Flexible, preprinted, color-coded, acrylic band sized to suit the diameter of the item it identifies.
  - 2. Type: Preprinted, flexible, self-adhesive, vinyl. Legend is over-laminated with a clear, weather- and chemical-resistant coating.
  - 3. Color: Black letters on orange background.
  - 4. Legend: Indicates voltage.

- C. Colored Adhesive Marking Tape for Raceways, Wires, and Cables: Self-adhesive vinyl tape, not less than 1 inch wide by 3 mils thick (25 mm wide by 0.08 mm thick).
  - D. Underground Warning Tape: Permanent, bright-colored, continuous-printed, vinyl tape with the following features:
    - 1. Not less than 6 inches wide by 4 mils thick (150 mm wide by 0.102 mm thick).
    - 2. Compounded for permanent direct-burial service.
    - 3. Embedded continuous metallic strip or core.
    - 4. Printed legend that indicates type of underground line.
  - E. Tape Markers for Wire: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.
  - F. Color-Coding Cable Ties: Type 6/6 nylon, self-locking type. Colors to suit coding scheme.
  - G. Engraved-Plastic Labels, Signs, and Instruction Plates: Engraving stock, melamine plastic laminate punched or drilled for mechanical fasteners 1/16-inch (1.6-mm) minimum thickness for signs up to 20 sq. in. (129 sq. cm) and 1/8-inch (3.2-mm) minimum thickness for larger sizes. Engraved legend in black letters on white background.
  - H. Interior Warning and Caution Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145. Preprinted, aluminum, baked-enamel-finish signs, punched or drilled for mechanical fasteners, with colors, legend, and size appropriate to the application.
  - I. Exterior Warning and Caution Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm), galvanized-steel backing, with colors, legend, and size appropriate to the application. 1/4-inch (6-mm) grommets in corners for mounting.
  - J. Fasteners for Nameplates and Signs: Self-tapping, stainless-steel screws or No. 10/32 stainless-steel machine screws with nuts and flat and lock washers.
- 2.4 TOUCHUP PAINT
- A. For Equipment: Equipment manufacturer's paint selected to match installed equipment finish.
  - B. Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

### **PART 3 - EXECUTION**

#### **3.1 ELECTRICAL EQUIPMENT INSTALLATION**

- A. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide the maximum possible headroom.
- B. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.
- C. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.
- D. Right of Way: Give to raceways and piping systems installed at a required slope.
- E. Seismic: Provide seismic bracing as required by local code.

### 3.2 RACEWAY AND CABLE INSTALLATION

- A. Conceal raceways and cables, unless otherwise indicated, within finished walls, ceilings, and floors.
- B. Install raceways and cables at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Locate horizontal raceway runs above water and steam piping.
- C. Use temporary raceway caps to prevent foreign matter from entering.
- D. Make conduit bends and offsets so ID is not reduced. Keep legs of bends in the same plane and straight legs of offsets parallel, unless otherwise indicated.
- E. Use raceway and cable fittings compatible with raceways and cables and suitable for use and location.
- F. Install raceways embedded in slabs in middle third of slab thickness where practical, and leave at least 2-inch (25-mm) concrete cover.
  - 1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
  - 2. Space raceways laterally to prevent voids in concrete.
  - 3. Install conduit larger than 1-inch trade size (DN27) parallel to or at right angles to main reinforcement. Where conduit is at right angles to reinforcement, place conduit close to slab support.
  - 4. Transition from nonmetallic tubing to Schedule 80 nonmetallic conduit, rigid steel conduit, or IMC before rising above floor.
  - 5. Make bends in exposed parallel or banked runs from same centerline to make bends parallel. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for exposed parallel raceways.
- G. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of the pull wire.
- H. Install telephone and signal system raceways, 2-inch trade size (DN53) and smaller, in maximum lengths of 150 feet (45 m) and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements, in addition to requirements above.
- I. Connect motors and equipment subject to vibration, noise transmission, or movement with a maximum of 72-inch (1830-mm) flexible conduit. Install LFMC in wet or damp locations. Install separate ground conductor across flexible connections.
- J. Set floor boxes level and trim after installation to fit flush to finished floor surface.

### 3.3 WIRING METHODS FOR POWER, LIGHTING, AND CONTROL CIRCUITS

- A. Feeders: Type THHN/THWN insulated conductors in raceway.
- B. Underground Feeders and Branch Circuits: Type THWN or single-wire, Type UF insulated conductors in raceway.
- C. Branch Circuits: Type THHN/THWN insulated conductors in raceway.
- D. Branch Circuits: Type THW or THHN/THWN insulated conductors in raceway where exposed. Metal-clad cable for lighting fixture whips no more than 6 feet in length, and where concealed in ceilings and gypsum board partitions.

- E. Remote-Control Signaling and Power-Limited Circuits: Type THHN/THWN insulated conductors in raceway for Classes 1, 2, and 3, unless otherwise indicated.

### 3.4 WIRING INSTALLATION

- A. Install splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- B. Install wiring at outlets with at least 12 inches (300 mm) of slack conductor at each outlet.
- C. Connect outlet and component connections to wiring systems and to ground. Tighten electrical connectors and terminals, according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

### 3.5 ELECTRICAL SUPPORTING DEVICE APPLICATION

- A. Damp Locations and Outdoors: Hot-dip galvanized materials or nonmetallic, U-channel system components.
- B. Dry Locations: Steel materials.
- C. Support Clamps for PVC Raceways: Click-type clamp system.
- D. Selection of Supports: Comply with manufacturer's written instructions.
- E. Strength of Supports: Adequate to carry present and future loads, times a safety factor of at least four; minimum of 200-lb (90-kg) design load and installed per seismic requirements.

### 3.6 SUPPORT INSTALLATION

- A. Install support devices to securely and permanently fasten and support electrical components.
- B. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.
- C. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.
- D. Size supports for multiple raceway installations so capacity can be increased by a 25 percent minimum in the future.
- E. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.
- F. Install 1/4-inch- (6-mm-) diameter or larger threaded steel hanger rods, unless otherwise indicated.
- G. Spring-steel fasteners specifically designed for supporting single conduits or tubing may be used instead of malleable-iron hangers for 1-1/2-inch (38-mm) and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings and for fastening raceways to slotted channel and angle supports.
- H. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.
- I. Simultaneously install vertical conductor supports with conductors.

- J. Separately support cast boxes that are threaded to raceways and used for fixture support. Support sheet-metal boxes directly from the building structure or by bar hangers. If bar hangers are used, attach bar to raceways on opposite sides of the box and support the raceway with an approved fastener not more than 24 inches (610 mm) from the box.
- K. Install metal channel racks for mounting cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.
- L. Install sleeves for cable and raceway penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.
- M. Securely fasten electrical items and their supports to the building structure, unless otherwise indicated. Perform fastening according to the following unless other fastening methods are indicated:
  - 1. Wood: Fasten with wood screws.
  - 2. Masonry: Toggle bolts on hollow masonry units and expansion bolts on solid masonry units.
  - 3. New Concrete: Concrete inserts with machine screws and bolts.
  - 4. Existing Concrete: Expansion bolts or threaded studs driven by a powder charge and provided with lock washers (if allowed by local authorities and approved by Architect).
  - 5. Steel: Welded threaded studs or spring-tension clamps on steel.
    - a. Field Welding: Comply with AWS D1.1.
  - 6. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or other items.
  - 7. Light Steel: Sheet-metal screws.
  - 8. Fasteners: Select so the load applied to each fastener does not exceed 50 percent of its proof-test load.
  - 9. Provide diagonal supports and all other requirements to support per seismic zone requirements.

### 3.7 IDENTIFICATION MATERIALS AND DEVICES

- A. Install at locations for most convenient viewing without interference with operation and maintenance of equipment.
- B. Coordinate names, abbreviations, colors, and other designations used for electrical identification with corresponding designations indicated in the Contract Documents or required by codes and standards. Use consistent designations throughout Project.
- C. Self-Adhesive Identification Products: Clean surfaces before applying.
- D. Identify raceways and cables with color banding as follows:
  - 1. Bands: use pre-tensioned, snap-around, colored plastic sleeves or colored adhesive marking tape. Make each color band 2 inches (51 mm) wide, completely encircling conduit, and place adjacent bands of two-color markings in contact, side by side.
  - 2. Band Locations: At changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (8-m) maximum intervals in congested areas.
  - 3. Colors: As follows:
    - a. Fire Alarm System: Red.
    - b. Security System: Blue and yellow.

- c. Telecommunication System: Green and yellow.
  - d. Power: black or white
- E. Tag and label circuits designated to be extended in the future. Identify source and circuit numbers in each cabinet, pull and junction box, and outlet box. Color-coding may be used for voltage and phase identification.
- F. Install continuous underground plastic markers during trench backfilling, for exterior underground power, control, signal, and communication lines located directly above power and communication lines. Locate 6 to 8 inches (150 to 200 mm) below finished grade. If width of multiple lines installed in a common trench or concrete envelope does not exceed 16 inches (400 mm), overall, use a single line marker.
- G. Color-code 240 or 208Y/120V system secondary service, feeder, and branch-circuit conductors throughout the secondary electrical system as follows:
- 1. Phase A: Black.
  - 2. Phase B: Red.
  - 3. Phase C: Blue.
- H. Color-code 480Y/277V system service, feeder, and branch-circuit conductors throughout the electrical system as follows:
- 1. Phase A: Yellow.
  - 2. Phase B: Brown.
  - 3. Phase C: Orange.

Reference NEC for additional color-coding requirements for neutrals and grounds.

- I. Install warning, caution, and instruction signs where required to comply with 29 CFR, Chapter XVII, Part 1910.145, and where needed to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.
- J. Install engraved-laminated emergency-operating signs with white letters on red background with minimum 3/8-inch- (9-mm-) high lettering for emergency instructions on power transfer, load shedding, and other emergency operations.

### 3.8 FIRESTOPPING

- A. Apply fire-stopping to cable and raceway penetrations of fire-rated floor and wall assemblies to achieve fire-resistance rating of the assembly. Fire-stopping materials and installation requirements are specified in Division 7.

### 3.9 CUTTING AND PATCHING

- A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.
- B. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing fire-stopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

### 3.10 FIELD QUALITY CONTROL

- A. Inspect installed components for damage and faulty work, including the following:
  - 1. Raceways.
  - 2. Building wire and connectors.
  - 3. Supporting devices for electrical components.
  - 4. Electrical identification.
  - 5. Electricity-metering components.
  - 6. Concrete bases.
  - 7. Electrical demolition.
  - 8. Cutting and patching for electrical construction.
  - 9. Touchup painting.

### 3.11 REFINISHING AND TOUCHUP PAINTING

- A. Refinish and touch up paint. Paint materials and application requirements are specified in Division 9.
  - 1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
  - 2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
  - 3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
  - 4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

### 3.12 CLEANING AND PROTECTION

- A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.
- B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

**END OF SECTION**

## SECTION 16075

### ELECTRICAL IDENTIFICATION

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. This section is a Division 16 Basic Electrical Requirements section, and is part of each Division 16 section making reference to electrical related work specified herein.

##### 1.2 SUMMARY

- A. This Section includes electrical identification materials and devices required to comply with ANSI C2, NFPA 70, OSHA standards, and authorities having jurisdiction.

##### 1.3 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.
- B. Schedule of Nomenclature: An index of electrical equipment and system components used in identification signs and labels.
- C. Samples: For each type of label and sign to illustrate color, lettering style, and graphic features of identification products.

##### 1.4 QUALITY ASSURANCE

- A. Comply with ANSI C2.
- B. Comply with NFPA 70.
- C. Comply with ANSI A13.1 and NFPA 70 for color-coding.

#### PART 2 - PRODUCTS

##### 2.1 RACEWAY AND CABLE LABELS

- A. Comply with ANSI A13.1, Table 3, for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
  - 1. Color: Black letters on orange field.
  - 2. Legend: Indicates voltage and service.
- B. Adhesive Labels: Preprinted, flexible, self-adhesive vinyl with legend overlaminated with a clear, weather- and chemical-resistant coating.

- C. Pretensioned, Wraparound Plastic Sleeves: Flexible, preprinted, color-coded, acrylic band sized to suit the diameter of the line it identifies and arranged to stay in place by pretensioned gripping action when placed in position.
- D. Colored Adhesive Tape: Self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide (0.08 mm thick by 25 to 51 mm wide).
- E. Underground-Line Warning Tape: Permanent, bright-colored, continuous-printed, vinyl tape.
  - 1. Not less than 6 inches wide by 4 mils thick (152 mm wide by 0.102 mm thick).
  - 2. Compounded for permanent direct-burial service.
  - 3. Embedded continuous metallic strip or core.
  - 4. Printed legend indicating type of underground line.
- F. Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.
- G. Aluminum, Wraparound Marker Bands: Bands cut from 0.014-inch- (0.4-mm-) thick aluminum sheet, with stamped or embossed legend, and fitted with slots or ears for permanently securing around wire or cable jacket or around groups of conductors.
- H. Plasticized Card-Stock Tags: Vinyl cloth with preprinted and field-printed legends. Orange background, unless otherwise indicated, with eyelet for fastener.
- I. Aluminum-Faced, Card-Stock Tags: Weather-resistant, 18-point minimum card stock faced on both sides with embossable aluminum sheet, 0.002 inch (0.05 mm) thick, laminated with moisture-resistant acrylic adhesive, punched for fasteners, and preprinted with legends to suit each application.
- J. Brass or Aluminum Tags: 2 by 2 by 0.05-inch (51 by 51 by 1.3-mm) metal tags with stamped legend, punched for fastener.

## 2.2 NAMEPLATES AND SIGNS

- A. Safety Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145.
- B. Engraved Plastic Nameplates and Signs: Engraving stock, melamine plastic laminate, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. in. (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.
  - 1. Engraved legend with black letters on white face.
  - 2. Punched or drilled for mechanical fasteners.
- C. Baked-Enamel Signs for Interior Use: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for the application. 1/4-inch (6.4-mm) grommets in corners for mounting.
- D. Exterior, Metal-Backed, Butyrate Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for the application. 1/4-inch (6.4-mm) grommets in corners for mounting.
- E. Fasteners for Nameplates and Signs: Self-tapping, stainless-steel screws or No. 10/32, stainless-steel machine screws with nuts and flat and lock washers.

## 2.3 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon cable ties.
  - 1. Minimum Width: 3/16 inch (5 mm).
  - 2. Tensile Strength: 50 lb (22.3 kg) minimum.
  - 3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
  - 4. Color: According to color-coding.
  
- B. Paint: Formulated for the type of surface and intended use.
  - 1. Primer for Galvanized Metal: Single-component acrylic vehicle formulated for galvanized surfaces.
  - 2. Primer for Concrete Masonry Units: Heavy-duty-resin block filler.
  - 3. Primer for Concrete: Clear, alkali-resistant, binder-type sealer.
  - 4. Enamel: Silicone-alkyd or alkyd urethane as recommended by primer manufacturer.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Identification Materials and Devices: Install at locations for most convenient viewing without interference with operation and maintenance of equipment.
  
- B. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and other designations with corresponding designations in the Contract Documents or with those required by codes and standards. Use consistent designations throughout Project.
  
- C. Sequence of Work: If identification is applied to surfaces that require finish, install identification after completing finish work.
  
- D. Self-Adhesive Identification Products: Clean surfaces before applying.
  
- E. Circuits with More Than 600 V: Identify raceway and cable with "DANGER--HIGH VOLTAGE" in black letters 2 inches (51 mm) high, stenciled with paint at 10-foot (3-m) intervals over a continuous, painted orange background. Identify the following:
  - 1. Entire floor area directly above conduits running beneath and within 12 inches (305 mm) of a basement or ground floor that is in contact with earth or is framed above unexcavated space.
  - 2. Wall surfaces directly external to conduits concealed within wall.
  - 3. All accessible surfaces of concrete envelope around conduits in vertical shafts, exposed in the building, or concealed above suspended ceilings.
  - 4. Entire surface of exposed conduits.
  
- F. Install painted identification according to manufacturer's written instructions and as follows:
  - 1. Clean surfaces of dust, loose material, and oily films before painting.
  - 2. Prime surfaces using type of primer specified for surface.
  - 3. Apply one intermediate and one finish coat of enamel.
  
- G. Color Banding Raceways and Exposed Cables: Band exposed and accessible raceways of the systems listed below:
  - 1. Bands: Pretensioned, wraparound plastic sleeves; colored adhesive tape; or a combination of both. Make each color band 2 inches (51 mm) wide, completely encircling conduit, and place adjacent bands of two-color markings in contact, side by side.

2. Band Locations: At changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.
3. Apply the following colors to the systems listed below:
  - a. Fire Alarm System: Red.
  - b. Fire-Suppression Supervisory and Control System: Red and yellow.
  - c. Combined Fire Alarm and Security System: Red and blue.
  - d. Security System: Blue and yellow.
  - e. Mechanical and Electrical Supervisory System: Green and blue.
  - f. Telecommunication System: Green and yellow.
  
- H. Caution Labels for Indoor Boxes and Enclosures for Power and Lighting: Install pressure-sensitive, self-adhesive labels identifying system voltage with black letters on orange background. Install on exterior of door or cover.
  
- I. Circuit Identification Labels on Boxes: Install labels externally.
  1. Exposed Boxes: Pressure-sensitive, self-adhesive plastic label on cover.
  2. Concealed Boxes: Plasticized card-stock tags.
  3. Labeling Legend: Permanent, waterproof listing of panel and circuit number or equivalent.
  
- J. Paths of Underground Electrical Lines: During trench backfilling, for exterior underground power, control, signal, and communication lines, install continuous underground plastic line marker located directly above line at 6 to 8 inches (150 to 200 mm) below finished grade. Where width of multiple lines installed in a common trench or concrete envelope does not exceed 16 inches (400 mm) overall, use a single line marker. Install line marker for underground wiring, both direct-buried cables and cables in raceway.
  
- K. Color-Coding of Secondary Phase Conductors: Use the following colors for service, feeder, and branch-circuit phase conductors:
  1. 208/120-V Conductors:
    - a. Phase A: Black.
    - b. Phase B: Red.
    - c. Phase C: Blue.
  2. Factory apply color the entire length of conductors, except the following field-applied, color-coding methods may be used instead of factory-coded wire for sizes larger than No. 10 AWG:
    - a. Colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Use 1-inch- (25-mm-) wide tape in colors specified. Adjust tape bands to avoid obscuring cable identification markings.
    - b. Colored cable ties applied in groups of three ties of specified color to each wire at each terminal or splice point starting 3 inches (76 mm) from the terminal and spaced 3 inches (76 mm) apart. Apply with a special tool or pliers, tighten to a snug fit, and cut off excess length.
  
- L. Power-Circuit Identification: Metal tags or aluminum, wraparound marker bands for cables, feeders, and power circuits in vaults, pull and junction boxes, manholes, and switchboard rooms.
  1. Legend: 1/4-inch- (6.4-mm-) steel letter and number stamping or embossing with legend corresponding to indicated circuit designations.
  2. Tag Fasteners: Nylon cable ties.
  3. Band Fasteners: Integral ears.

- M. Apply identification to conductors as follows:
1. Conductors to Be Extended in the Future: Indicate source and circuit numbers.
  2. Multiple Power or Lighting Circuits in the Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color-coding to identify circuits' voltage and phase.
  3. Multiple Control and Communication Circuits in the Same Enclosure: Identify each conductor by its system and circuit designation. Use a consistent system of tags, color-coding, or cable marking tape.
- N. Apply warning, caution, and instruction signs as follows:
1. Warnings, Cautions, and Instructions: Install to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.
  2. Emergency Operation: Install engraved laminated signs with white legend on red background with minimum 3/8-inch- (9-mm-) high lettering for emergency instructions on power transfer, load shedding, and other emergency operations.
- O. Equipment Identification Labels: Engraved plastic laminate. Install on each unit of equipment, including central or master unit of each system. This includes power, lighting, communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high lettering on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high. Use white lettering on black field. Apply labels for each unit of the following categories of equipment using mechanical fasteners:
1. Panelboards, electrical cabinets, and enclosures.
  2. Access doors and panels for concealed electrical items.
  3. Electrical switchgear and switchboards.
  4. Electrical substations.
  5. Emergency system boxes and enclosures.
  6. Motor-control centers.
  7. Disconnect switches.
  8. Enclosed circuit breakers.
  9. Motor starters.
  10. Push-button stations.
  11. Power transfer equipment.
  12. Contactors.
  13. Remote-controlled switches.
  14. Control devices.
  15. Equipment racks for data, telecomm, video, security, and audio systems.

**END OF SECTION**

## SECTION 16120

### CONDUCTORS AND CABLES

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

##### 1.2 SUMMARY

- A. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

##### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Qualification Data: For testing agency.
- C. Field Quality-Control Test Reports: From a qualified testing and inspecting agency engaged by Contractor, or from contractor where allowed by Division 1 requirements.

##### 1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the InterNational Electrical Testing Association and that is acceptable to authorities having jurisdiction.
  - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.

##### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Provide factory-wrapped water-proof flexible barrier material for covering wire and cable wood reels, where applicable; and weather resistant fiberboard containers for factory-packaging of cable, wire and connectors, to protect against physical damage in transit. Damaged cable, wire or connectors shall be removed from project site.
- B. In their factory-furnished coverings, store cable, wire and connectors in a clean, dry indoor space which provides protection against the weather.

## PART 2 - PRODUCTS

### 2.1 GENERAL

- A. Cable, wire and connectors shall be of manufacturer's standard materials, as indicated by published product information. Design and construction as required for the installation.
- B. Provide factory-fabricated wire of the size, rating, material and type as indicated for each service. Where not indicated, provide proper selection as required to comply with installation requirements and with NEC standards. The minimum size wire to be used for power or lighting circuits shall be #12 copper with insulation as noted below. Minimum size for control shall be #14 copper.

### 2.2 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

### 2.3 CONDUCTORS AND CABLES

- A. Manufacturers:
  - 1. American Insulated Wire Corp.; a Leviton Company.
  - 2. General Cable Corporation.
  - 3. Senator Wire & Cable Company.
  - 4. Southwire Company.
- B. Conductor Material: Copper complying with NEMA WC 5 or 7; solid conductor for No. 10 AWG and smaller, stranded for No. 8 AWG and larger.

### 2.4 REMOTE CONTROL AND SIGNAL CABLE

- A. Control Cable for Class 1 Remote Control and Signal Circuits: Provide 98% conductivity copper conductors, 600 volt insulation, rated 60/75 degree C, individual conductors twisted together, shielded, and covered with a PVC jacket and an aluminum sheath. Provide with interlocked steel armor with an overall PVC jacket where subject to damage.
- B. Control Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Provide 98% conductivity copper conductor, 300 volt insulation, rated 60/75 degree C, individual conductors twisted together, shielded, and covered with a PVC jacket; assembly UL listed.
- C. Plenum Cable for Class 3 Remote Control and Signal Circuits: Provide 98% conductivity copper conductor, 300 volt insulation, rated 75 degree C, individual conductors twisted together, shielded, and covered with a nonmetallic jacket; UL listed for use in return spaces, and spaces used as ducts and plenums.

## 2.5 CONNECTORS AND SPLICES

### A. Manufacturers:

1. AFC Cable Systems, Inc.
2. AMP Incorporated/Tyco International.
3. Hubbell/Anderson.
4. O-Z/Gedney; EGS Electrical Group LLC.
5. 3M Company; Electrical Products Division.

### B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated. Where not indicated, provide proper selection as required to comply with installation requirements and with NEC standards.

## PART 3 - EXECUTION

### 3.1 INSPECTION

- #### A.
- Installer must examine the areas and conditions under which cable, wire and connectors are to be installed and notify the Contractor and Architect in writing of any conditions detrimental to the proper and timely completion of the work. Inspect wire and cable for physical damage. Do not proceed with the work until unsatisfactory conditions have been corrected.

### 3.2 CONDUCTOR AND INSULATION APPLICATIONS

- #### A.
- Select cables on the basis of their purpose and UL listing.
- #### B.
- Coordinate cable and wire installation work with electrical raceway and equipment installation work, as necessary for proper interface.
- #### C.
- Service Entrance: Type THHN/THWN, single conductors in raceway, XHHW, single conductors in raceway
- #### D.
- Feeders Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN, single conductors in raceway..
- #### E.
- Feeders Concealed in Concrete, below Slabs-on-Grade, and in Crawlspace: Type THHN-THWN, single conductors in raceway.
- #### F.
- Exposed Branch Circuits, including in Crawlspace: Type THHN/THWN, single conductors in raceway. Reference drawings for specifically allowed uses of Armored cable, Type AC and Metal-clad cable, Type MC.
- #### G.
- Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN, single conductors in raceway Under specific conditions noted on drawings, Armored cable, Type AC or Metal-clad cable, Type MC may be allowed.
- #### H.
- Branch Circuits Concealed in Concrete and below Slabs-on-Grade: Type THHN-THWN, single conductors in raceway.

- I. Underground Feeders and Branch Circuits: Type THHN/THWN, single conductors in raceway or Type UF multi-conductor cable.
- J. Fire Alarm Circuits: Type THHN/THWN, in raceway or Power-limited, fire-protective, signaling circuit cable as allowed by Authority Having Jurisdiction, and by local practice.
- K. Class 1 Control Circuits: Type THHN/THWN, in raceway.
- L. Class 2 Control Circuits: Type THHN/THWN, in raceway, Power-limited cable, concealed in building finishes or Power-limited tray cable, in cable tray.

### 3.3 INSTALLATION

- A. Install electrical cable, wire and connectors as indicated, in accordance with the manufacturer's written instructions, the applicable requirements of NEC and the National Electrical Contractors Association's "Standard of Installation", and as required to ensure that products serve the intended functions.
- B. Coordinate cable and wire installation work with electrical raceway and equipment installation work, as necessary for proper interface.
- C. No conductor smaller than No. 12 wire shall be used for lighting purposes. In the case of "home runs" over 100' in length no conductor smaller than a No. 10 wire shall be used. The sizing of all wire except remote control wire shall be accomplished in the case of both feeder and branch circuits by conforming to the following provisions:
  - 1. 120/208 Volt Branch Circuits: The voltage drop in the case of 120/208 volt circuits shall not exceed 3.0% at maximum load and 70.0% power factor.
- D. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- E. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- F. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.
- G. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- H. Support cables according to Division 16 Section "Basic Electrical Materials and Methods."
- I. Seal around cables penetrating fire-rated elements according to Division 7 requirements.
- J. Identify and color-code conductors and cables according to Division 16 Section "Basic Electrical Materials and Methods" and "Electrical Identification."

### 3.4 WIRING INSTALLATION IN RACEWAYS

- A. Pull wire and cable into clean dry conduit.
- B. Pull conductors together where more than one is being installed in a raceway.

- C. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.
- D. Place an equal number of conductors for each phase of a circuit in same raceway.

### 3.5 CABLE INSTALLATION

- A. Provide protection for exposed cables where subject to damage.
- B. Support cables above accessible ceilings; do not rest on ceiling tiles.
- C. Use suitable cable fittings and connectors.

### 3.6 CONNECTIONS AND TERMINATIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
  - 1. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.
- C. Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.
- D. Keep conductor splices and taps accessible and to a minimum, and in junction boxes only.
- E. Use splice, tap and termination connectors which are compatible with the conductor material.
- F. Thoroughly clean wires before installing lugs and connectors.
- G. Wiring at Outlets: Install conductors at each outlet with at least **6 inches (150 mm)** of slack.

### 3.7 FIELD QUALITY CONTROL

- A. Torque test conductor connections and terminations to manufacturer's recommended values.
- B. Perform continuity test on all power and equipment branch circuit conductors. Verify proper phasing connections.
- C. Conductors in vertical conduits or raceways shall be supported in the manner set forth in the appropriate section of the latest revision of the National Electrical Code. Lighting fixtures shall not be used for raceways for circuits other than parallel wiring of fixtures.

### 3.8 TESTING AND ACCEPTANCE

- A. Perform the following field quality-control testing:
  - 1. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with requirements.
  - 2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.3.1. Certify compliance with test parameters.

- B. Before final acceptance, make all voltage, insulation, and load tests necessary to demonstrate to the Owner's representative the satisfactory installation and proper performance of all circuits
- C. Test Reports: Prepare a written report to record the following:
  - 1. Test procedures used.
  - 2. Test results that comply with requirements.
  - 3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- D. At completion of project, provide complete and finally corrected working drawings per Division 1 requirements.

**END OF SECTION**

**SECTION 16130**  
**RACEWAYS AND BOXES**

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
- B. Related Sections include the following:
  - 1. Division 2 for exterior ductbanks, manholes, and underground utility construction.
  - 2. Division 7 for firestopping materials and installation at penetrations through walls, ceilings, and other fire-rated elements.
  - 3. Division 16 Section "Basic Electrical Materials and Methods" for supports, anchors, and identification products.
  - 4. Division 16 Section "Wiring Devices" for devices installed in boxes and for floor-box service fittings.

1.3 DEFINITIONS

- A. RGC: Rigid galvanized steel conduit
- B. IMC: Intermediate metallic conduit
- C. EMT: Electrical metallic tubing.
- D. ENT: Electrical nonmetallic tubing.
- E. FMC: Flexible metal conduit.
- F. IMC: Intermediate metal conduit.
- G. LFMC: Liquidtight flexible metal conduit.
- H. LFNC: Liquidtight flexible nonmetallic conduit.
- I. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

- B. Shop Drawings: Show fabrication and installation details of components for raceways, fittings, boxes, enclosures, and cabinets.

#### 1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

#### 1.6 COORDINATION

- A. Coordinate layout and installation of raceways, boxes, enclosures, cabinets, and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

### **PART 2 - PRODUCTS**

#### 2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

#### 2.2 METAL CONDUIT AND TUBING

- A. Available Manufacturers:
  - 1. AFC Cable Systems, Inc.
  - 2. Alflex Inc.
  - 3. Anamet Electrical, Inc.; Anaconda Metal Hose.
  - 4. Electri-Flex Co.
  - 5. Grinnell Co./Tyco International; Allied Tube and Conduit Div.
  - 6. LTV Steel Tubular Products Company.
  - 7. Manhattan/CDT/Cole-Flex.
  - 8. O-Z Gedney; Unit of General Signal.
  - 9. Wheatland Tube Co.
- B. Rigid Steel Conduit: ANSI C80.1.
- C. Aluminum Rigid Conduit: ANSI C80.5.
- D. IMC: ANSI C80.6.
- E. Plastic-Coated Steel Conduit and Fittings: NEMA RN 1.
- F. Plastic-Coated IMC and Fittings: NEMA RN 1.

- G. EMT and Fittings: ANSI C80.3.
  - 1. Fittings: **Compression** type only (set screws are not acceptable and will not be considered for substitution).
- H. FMC: Zinc-coated steel.
- I. LFMC: Flexible steel conduit with PVC jacket.
- J. Fittings: NEMA FB 1; compatible with conduit and tubing materials.

## 2.3 NONMETALLIC CONDUIT AND TUBING

- A. Available Manufacturers:
  - 1. American International.
  - 2. Anamet Electrical, Inc.; Anaconda Metal Hose.
  - 3. Arnco Corp.
  - 4. Cantex Inc.
  - 5. Certainteed Corp.; Pipe & Plastics Group.
  - 6. Condux International.
  - 7. ElecSYS, Inc.
  - 8. Electri-Flex Co.
  - 9. Lamson & Sessions; Carlon Electrical Products.
  - 10. Manhattan/CDT/Cole-Flex.
  - 11. RACO; Division of Hubbell, Inc.
  - 12. Spiralduct, Inc./AFC Cable Systems, Inc.
  - 13. Thomas & Betts Corporation.
- B. ENT: NEMA TC 13.
- C. RNC: NEMA TC 2, Schedule 40 and Schedule 80 PVC.
- D. ENT and RNC Fittings: NEMA TC 3; match to conduit or tubing type and material.
- E. LFNC: UL 1660.

## 2.4 METAL WIREWAYS

- A. Available Manufacturers:
  - 1. Hoffman.
  - 2. Square D.
  - 3. Others as approved by Design Professional
- B. Material and Construction: Sheet metal sized and shaped as indicated, NEMA 1 or 3R as required by application. Use NEMA 3R for all exterior applications. Use other NEMA configurations as required or as indicated on drawings.
- C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.

- E. Wireway Covers: Hinged type, Screw-cover type, Flanged-and-gasketed type, or as indicated on drawings.
- F. Finish: Manufacturer's standard gray enamel finish.

## 2.5 BOXES, ENCLOSURES, AND CABINETS

### A. Manufacturers:

1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
2. Emerson/General Signal; Appleton Electric Company.
3. Erickson Electrical Equipment Co.
4. Hoffman.
5. Hubbell, Inc.; Killark Electric Manufacturing Co.
6. O-Z/Gedney; Unit of General Signal.
7. RACO; Division of Hubbell, Inc.
8. Robroy Industries, Inc.; Enclosure Division.
9. Scott Fetzer Co.; Adalet-PLM Division.
10. Spring City Electrical Manufacturing Co.
11. Thomas & Betts Corporation.
12. Walker Systems, Inc.; Wiremold Company (The).
13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.

### B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

### C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover.

### D. Floor Boxes: Cast metal, fully adjustable, rectangular.

### E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

### F. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.

### G. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures: Plastic, finished inside with radio-frequency-resistant paint.

### H. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage and include accessory feet where required for freestanding equipment.

## 2.6 FACTORY FINISHES

### A. Finish: For raceway, enclosure, or cabinet components, provide manufacturer's standard prime-coat finish ready for field painting.

### B. Finish: For raceway, enclosure, or cabinet components, provide manufacturer's standard gray paint applied to factory-assembled surface raceways, enclosures, and cabinets before shipping.

## PART 3 - EXECUTION

### 3.1 RACEWAY APPLICATION

#### A. Outdoors:

1. Exposed: Rigid steel.
2. Concealed: Rigid steel.
3. Subject to damage: RGC.
4. Underground, Single Run: RNC with RGC turns.
5. Underground, Grouped: RNC with RGC turns.
6. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
7. Boxes and Enclosures: NEMA 250, Type **3R**

#### B. Indoors:

1. Exposed: RGC.
2. Concealed: EMT or IMC.
3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC; with separate insulated green ground wire bonded to metal raceway or components at each end.
4. Damp or Wet Locations: RGC.
5. Subject to damage: RGC.
6. Boxes and Enclosures: NEMA 250, Type 1, except as follows:
  - a. Damp or Wet Locations: NEMA 250, Type 3rR.

#### C. Minimum Raceway Size: **3/4-inch trade size (DN 21)**.

#### D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduits.
3. EMT: Compression fittings.

#### E. Do not use aluminum conduits.

#### F. Coat all metallic conduit used below grade with asphaltum or other water-proof sealant.

### 3.2 INSTALLATION

- A. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- B. Complete raceway installation before starting conductor installation.
- C. Support raceways as specified in Division 16 Section "Basic Electrical Materials and Methods."
- D. Install temporary closures to prevent foreign matter from entering raceways.

- E. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab. Seal stub-ups properly.
- F. Make bends and offsets so inside diameter is not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
  - 1. Install concealed raceways with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.
- H. Raceways Embedded in Slabs: Install in middle 1/3 of slab thickness where practical and leave at least 2 inches (50 mm) of concrete cover.
  - 1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
  - 2. Space raceways laterally to prevent voids in concrete.
  - 3. Run conduit larger than 1-inch trade size (DN 27) parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
  - 4. Change from nonmetallic tubing to Schedule 80 nonmetallic conduit, rigid steel conduit, or IMC before rising above the floor.
- I. Install exposed raceways parallel or at right angles to nearby surfaces or structural members and follow surface contours as much as possible.
  - 1. Run parallel or banked raceways together on common supports.
  - 2. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.
  - 3. Routing of exposed conduit in public spaces must be approved by Architect. Include and indicate such exposed conduit in shop drawings. Obtain approval from Architect prior to installation.
- J. Join raceways with fittings designed and approved for that purpose and make joints tight.
  - 1. Use insulating bushings to protect conductors.
  - 2. Install insulating bushings at joints and terminations of conduit. Do not leave bare edges of conduit ends exposed.
  - 3. Fitting shall be threaded type for Rigid and compression type for EMT. No setscrew fittings will be allowed.
- K. Terminations:
  - 1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
  - 2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.
- L. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. In runs longer than 150 feet (45 m) use polypropylene or monofilament plastic line with not less than 300-lb (135-kg) tensile strength. Install pull boxes at distances suitable for installation of wiring and equipment used for pulls.

- M. Telephone and Signal System Raceways, 2-Inch Trade Size (DN 53) and Smaller: In addition to above requirements, install raceways in maximum lengths of 150 feet (45 m) and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements. Accommodate requirements for pulling non-power wiring. Provide sufficient pull boxes to allow pulls according to the overall length of installation of conduit and tubing.
- N. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
  - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
  - 2. Where otherwise required by NFPA 70.
- O. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches (150 mm) above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.
- P. Flexible Connections: Use maximum of 72 inches (1830 mm) of flexible conduit for recessed and semi-recessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use LFMC in damp or wet locations, and for all connections to motors. Install separate ground conductor across flexible connections, with ground couplings at each end of conduit.
- Q. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying raceways to receptacle or fixture ground terminals.
- R. Set floor boxes level and flush with finished floor surface.
- S. Set floor boxes level. Trim after installation to fit flush with finished floor surface.
- T. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

### 3.3 PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
  - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
  - 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

### 3.4 CLEANING

- A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes.

**END OF SECTION**

## SECTION 16140

### WIRING DEVICES

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

##### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Single and duplex receptacles, ground-fault circuit interrupters, integral surge suppression units, and isolated-ground receptacles.
  - 2. Single- and double-pole snap switches and dimmer switches.
  - 3. Device wall plates.
  - 4. Pin and sleeve connectors and receptacles.
  - 5. Floor service outlets, poke-through assemblies, service poles, and multioutlet assemblies.

##### 1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. PVC: Polyvinyl chloride.
- D. RFI: Radio-frequency interference.
- E. TVSS: Transient voltage surge suppressor.
- F. UTP: Unshielded twisted pair.

##### 1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
- C. Samples: One for each type of device and wall plate specified, in each color specified.
- D. Field quality-control test reports.
- E. Schedule: for Work of this section 10 days prior to commencement of installation. Indicate work of other trades and coordination of installation with related items such as millwork, dry wall, and paint.

## 1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of wiring device through one source from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.

## 1.6 COORDINATION

- A. Receptacles for Owner-Furnished Equipment: Match plug configurations.
  - 1. Cord and Plug Sets: Match equipment requirements.
- B. Schedule installation of cover plates after the surface upon which they are installed has received final finish. Verify scheduling with other trades.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Wiring Devices:
    - a. Hubbell Incorporated; Wiring Device-Kellems.
    - b. Leviton Mfg. Company Inc.
    - c. Pass & Seymour/Legrand; Wiring Devices Div.
  - 2. Wiring Devices for Hazardous (Classified) Locations:
    - a. Crouse-Hinds/Cooper Industries, Inc.; Arrow Hart Wiring Devices.
    - b. EGS/Appleton Electric Company.
    - c. Killark Electric Manufacturing Co./Hubbell Incorporated.
  - 3. Multioutlet Assemblies:
    - a. Hubbell Incorporated; Wiring Device-Kellems.
    - b. Wiremold Company (The).
  - 4. Floor Service Outlets and Telephone/Power Poles:
    - a. Hubbell Incorporated; Wiring Device-Kellems.
    - b. Pass & Seymour/Legrand; Wiring Devices Div.
    - c. Square D/Groupe Schneider NA.
    - d. Thomas & Betts Corporation.
    - e. Wiremold Company (The)

## 2.2 WIRING DEVICES

- A. General: Provide wiring devices, in types, characteristics, grades, standard NEMA colors, and electrical ratings for applications indicated, which are UL listed and which comply with applicable UL and NEMA standards. Verify colors with Architect prior to purchasing and installing devices. Additional requirements beyond these may be given in drawings and schedules.

## 2.3 RECEPTACLES

- A. Body: Nylon, NEMA 5-20R configuration, verify style and color with architect.
- B. Straight-Blade-Type Receptacles: Comply with NEMA WD 1, NEMA WD 6, DSCC W-C-596G, and UL 498.
- C. Straight-Blade: Heavy Duty grade.
- D. Locking receptacles: Heavy Duty grade.
- E. GFCI Receptacles: Straight blade, feed-through type, rectangular face standard style Heavy-Duty grade, with integral NEMA WD 6, Configuration 5-20R duplex receptacle; complying with UL 498 and UL 943. Design units for installation in a 2-3/4-inch- (70-mm-) deep outlet box without an adapter.
- F. Isolated-Ground Receptacles: Orange, straight blade, rectangular face standard style, Heavy-Duty grade, NEMA 5-20R duplex receptacle, with equipment grounding contacts connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap.
  - 1. Devices: Listed and labeled as isolated-ground receptacles.
  - 2. Isolation Method: Integral to receptacle construction and not dependent on removable parts.

## 2.4 SWITCHES

- A. Verify style and color with Architect prior to purchasing and installing.
- B. Body: Standard face, nylon, with dust collar.
- C. Single- and Double-Pole Switches: Comply with DSCC W-C-896F and UL 20. Provide in 2-way, 3-way, and 4-way configurations as required.
- D. Snap Switches: Heavy Duty grade, quiet type.
- E. Combination Switch and Receptacle: Both devices in a single gang unit with plaster ears and removable tab connector that permit separate or common feed connection.
  - 1. Switch: 20 A, 120/277-V ac.
  - 2. Receptacle: NEMA WD 6, Configuration 5-15R.
- F. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on/off switches and audible frequency and EMI/RFI filters.
  - 1. Control: Continuously adjustable slider with single-pole or three-way switching to suit connections.

2. Incandescent Lamp Dimmers: Modular, 120 V, 60 Hz with continuously adjustable rotary knob, toggle switch, or slider; single pole with soft tap or other quiet switch; EMI/RFI filter to eliminate interference; and 5-inch (130-mm) wire connecting leads.
3. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

## 2.5 WALL PLATES

- A. Verify style and color with Architect prior to purchasing and installing.
- B. Single and combination types to match corresponding wiring devices, with ganging and cutouts as indicated.
  1. Plate-Securing Screws: Metal with head color to match plate finish.
  2. Material for All Spaces (as indicated on drawings or as required herein):
    - a. **0.035-inch- (1-mm-)** thick, satin-finished stainless steel.
  3. Material for Wet Locations: Thermoplastic or Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations."
  4. Verify colors and finish with Architect prior to purchasing and installing.

## 2.6 FLOOR SERVICE FITTINGS

- A. Verify style and color with Architect prior to purchasing and installing.
- B. Type: Modular, flush-type or flap-type or above-floor, as indicated in drawings or as required herein, dual-service units suitable for wiring method used.
- C. Compartments: Barrier separates power from voice and data communication cabling.
- D. Service Plate: Rectangular or Round, die-cast aluminum or solid brass with satin finish, as indicated on drawings or as required herein. Confirm finish with architect prior to installation.
- E. Power Receptacle: NEMA WD 6, Configuration 5-20R, gray finish, unless otherwise indicated.
- F. Voice and Data Communication Outlet: Two modular, keyed, color-coded, RJ-45 Category 3 jacks for UTP cable and Two modular, keyed, color-coded, RJ-45 Category 5e jacks for UTP cable, or other configurations as indicated on drawings.

## 2.7 FINISHES

- A. Verify style and color with Architect prior to purchasing and installing.
- B. Color:
  1. Wiring Devices Connected to Normal Power System: provide per architect, unless otherwise indicated or required by NFPA 70.
  2. Isolated-Ground Receptacles: Orange, or as specified above, with orange triangle on face, or as indicated on drawings.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. General: Obtain approved submittal from Design Professionals (especially Engineer and Architect) prior to installation of any devices or materials. Notify Engineer of intent to commence work at least 7 calendar days prior to installation of any devices. Install wiring devices and accessories as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC, in accordance with recognized industry practices, and as required to fulfill project requirements, as directed by Engineer in field.
- B. Install devices and assemblies level, plumb, and square with building lines.
- C. Install wall dimmers to achieve indicated rating after derating for ganging according to manufacturer's written instructions.
- D. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' written instructions.
- E. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical, and with grounding terminal of receptacles on bottom. Group adjacent switches and devices under single, multi-gang wall plates.
- F. Arrangement of devices at millwork: Confirm arrangement at millwork with Architect. Reference drawings, plans, schedules, notes, and elevations. Unless noted otherwise, mount devices flush. Where devices are located in splashes, mount with long dimension horizontal. Where devices are located in other millwork, coordinate orientation of device with orientation of millwork component device is mounted in. Confirm locations, orientations, and methods of finish for all devices in and around millwork. Make confirmation through field verification with Architect or through shop drawings submitted for review and approval.
- G. Remove wall plates and protect devices and assemblies during painting.
- H. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.
- I. Install wiring devices only in electrical boxes that are clean and free from building materials, dirt, and debris.
- J. Install switches at 48 inches above finished floor unless noted otherwise on Drawings. Install receptacles at 18 inches above finished floor. Measure height from top of finished floor to center line of device.
- K. Cut rough-ins neatly. Oversized faceplates will not be accepted. Repair and re-finish any materials or surfaces damaged from cutting rough-ins or installing boxes or devices.
- L. Install single gang switches so that toggle or paddle position "up" corresponds to "ON."
- M. Mark wires at device termination with circuit number.

### 3.2 IDENTIFICATION

- A. Comply with other Division 16 Sections with identification requirements. Comply with additional requirements given in drawings and schedules.

### 3.3 CONNECTIONS

- A. Ground equipment according to Division 16 Section "Grounding and Bonding" and per current NEC requirements.
- B. All GFI, IG receptacles shall be grounded with a green insulated ground wire, run continuous and unspliced to panelboard ground bus. Despite any lack of instructions elsewhere, ensure that all panelboards accepting such grounds have ground buses suitable for quality grounding. Ground lugs are not acceptable methods of terminating branch circuit grounds. In no instance shall these receptacles be ungrounded, nor grounded to pigtails, the conduit or raceway, or otherwise improperly grounded.
- C. Connect wiring according to Division 16 Section "Conductors and Cables."
- D. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

### 3.4 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
  - 1. After installing wiring devices and after electrical circuitry has been energized, test for proper polarity, ground continuity, and compliance with requirements.
  - 2. Test GFCI operation with both local and remote fault simulations according to manufacturer's written instructions.
- B. Remove malfunctioning units, replace with new units, and retest as specified above.

**END OF SECTION**

## SECTION 16410

### ENCLOSED SWITCHES AND CIRCUIT BREAKERS

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

##### 1.2 SUMMARY

- A. This Section includes individually mounted enclosed switches and circuit breakers used for the following:
  - 1. Service disconnecting means.
  - 2. Feeder and branch-circuit protection.
  - 3. Motor and equipment disconnecting means.
- B. Related Sections include the following:
  - 1. Division 16 Section "Wiring Devices" for attachment plugs, receptacles, and toggle switches used for disconnecting means.
  - 2. Division 16 Section "Switchboards" for individually enclosed, fusible switches used as feeder protection.
  - 3. Division 16 Section "Fuses" for fusible devices.

##### 1.3 DEFINITIONS

- A. GFCI: Ground-fault circuit interrupter.
- B. RMS: Root mean square.
- C. SPDT: Single pole, double throw.

##### 1.4 SUBMITTALS

- A. Product Data: For each type of switch, circuit breaker, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each switch and circuit breaker.
  - 1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
    - a. Enclosure types and details for types other than NEMA 250, Type 1.
    - b. Current and voltage ratings.
    - c. Short-circuit current rating.
    - d. UL listing for series rating of installed devices.

- e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
  - 2. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
  - C. Maintenance Data: For enclosed switches and circuit breakers and for components to include in maintenance manuals specified in Division 1. In addition to requirements specified in Division 1 Section "Closeout Procedures," include the following:
    - 1. Routine maintenance requirements for components.
    - 2. Manufacturer's written instructions for testing and adjusting switches and circuit breakers.
    - 3. Time-current curves, including selectable ranges for each type of circuit breaker.
- 1.5 QUALITY ASSURANCE
- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
  - B. Comply with NEMA AB 1 and NEMA KS 1.
  - C. Comply with NFPA 70.
  - D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions. Coordinate with field conditions.
- 1.6 PROJECT CONDITIONS
- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
    - 1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 120 deg F (40 deg C).
    - 2. Altitude: Greater than 2000 feet.
- 1.7 COORDINATION
- A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- 1.8 EXTRA MATERIALS
- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
    - 1. Spares: For the following:
      - a. Control-Power Fuses: 1 of each type and rating.
      - b. Fuses and Fusible Devices for Fused Circuit Breakers: 3 of each type and rating.
      - c. Fuses for Fused Switches: 3 of each type and rating.
      - d. Fuses for Fused Power-Circuit Devices: 3 of each type and rating.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Fusible Switches:
    - a. Eaton Corp.; Cutler-Hammer Products.
    - b. General Electric Co.; Electrical Distribution & Control Division.
    - c. Siemens Energy & Automation, Inc.
    - d. Square D Co.

### **2.2 ENCLOSED SWITCHES**

- A. Enclosed, Non-fusible Switch: NEMA KS 1, Type HD, with lockable handle.
- B. Enclosed, Fusible Switch, 800 A and Smaller: NEMA KS 1, Type HD, with clips to accommodate specified fuses, lockable handle with two padlocks, and interlocked with cover in closed position.

### **2.3 ENCLOSURES**

- A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location.
  - 1. Outdoor Locations: NEMA 250, Type 3R.
  - 2. Kitchen Areas: NEMA 250, Type 1
  - 3. Other Wet or Damp Indoor Locations: NEMA 250, Type 3R.

### **2.4 FACTORY FINISHES**

- A. Manufacturer's standard prime-coat finish ready for field painting.
- B. Finish: Manufacturer's standard grey paint applied to factory-assembled and -tested enclosures before shipping.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance.
  - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

- A. Comply with mounting and anchoring requirements specified in Division 16 Section "Seismic Controls for Electrical Work."

- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

### 3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 16 Section Basic Electrical Materials and Methods and Electrical Identification."
- B. Enclosure Nameplates: Label each enclosure with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

### 3.4 CONNECTIONS

- A. Install equipment grounding connections for switches and circuit breakers with ground continuity to main electrical ground bus.
- B. Install power wiring. Install wiring between switches and circuit breakers, and control and indication devices.
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

### 3.5 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
  - 1. Test continuity of each line- and load-side circuit..

### 3.6 CLEANING

- A. On completion of installation, inspect interior and exterior of enclosures. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

**END OF SECTION**

## SECTION 16442

### PANELBOARDS

#### PART 1 - GENERAL

##### 1.1 SUMMARY

- A. This Section includes distribution panelboards and lighting and appliance branch-circuit panelboards.

##### 1.2 SUBMITTALS

- A. Product Data: For each type of panelboard, overcurrent protective device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
  - 1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:
    - a. Enclosure types and details for types other than NEMA 250, Type 1.
    - b. Bus configuration, current, and voltage ratings.
    - c. Short-circuit current rating of panelboards and overcurrent protective devices.
    - d. UL listing for series rating of installed devices.
    - e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
  - 2. Wiring Diagrams: Power, signal, and control wiring.
  - 3. Field quality-control test reports.
  - 4. Operation and maintenance data.

##### 1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NEMA PB 1.
- C. Comply with NFPA 70.

#### PART 2 - PRODUCTS

##### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Panelboards, Overcurrent Protective Devices, Controllers, Contactors, and Accessories:

- a. Eaton Corporation; Cutler-Hammer Products.
- b. General Electric Co.; Electrical Distribution & Protection Div.
- c. Siemens Energy & Automation, Inc.
- d. Square D.

## 2.2 MANUFACTURED UNITS

- A. Enclosures: Flush- and surface-mounted cabinets. NEMA PB 1, Type 1.
  - 1. Rated for environmental conditions at installed location.
    - a. Outdoor Locations: NEMA 250, Type 3R
  - 2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
  - 3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
- B. Phase and Ground Buses: Hard-drawn copper, 98 percent conductivity.
- C. Conductor Connectors: Suitable for use with conductor material.
  - 1. Ground Lugs and Bus Configured Terminators: Compression type.
- D. Service Equipment Label: UL labeled for use as service equipment for panelboards with main service disconnect switches.
- E. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.
- F. Panelboard Short-Circuit Rating:
  - 1. UL label indicating series-connected rating with integral or remote upstream overcurrent protective devices. Include size and type of upstream device allowable, branch devices allowable, and UL series-connected short-circuit rating.
  - 2. Fully rated to interrupt symmetrical short-circuit current available at terminals.

## 2.3 DISTRIBUTION PANELBOARDS

- A. Doors: Secured with vault-type latch with tumbler lock; keyed alike. Omit for fused-switch panelboards.
- B. Main Overcurrent Protective Devices: Circuit breaker.
- C. Branch Overcurrent Protective Devices:
  - 1. For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
  - 2. For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers;

## 2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

- B. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

## 2.5 OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker: UL 489, with series-connected rating or interrupting capacity to meet available fault currents.
  - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
  - 2. GFCI Circuit Breakers: Single- and two-pole configurations with 5 -mA trip sensitivity.
  - 3. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.
    - a. Lugs: Compression style, suitable for number, size, trip ratings, and conductor materials.
    - b. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
    - c. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at [55] percent of rated voltage.
- B. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
- C. Fuses to be type J.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Comply with mounting and anchoring requirements specified in Division 16 Section "Seismic Controls for Electrical Work."
- C. Mount top of trim max. 90 inches above finished floor, unless otherwise indicated.
- D. Mount plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.
- E. Install overcurrent protective devices and controllers.
  - 1. Set field-adjustable switches and circuit-breaker trip ranges.
- F. Install filler plates in unused spaces.
- G. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 16 Section "Basic Electrical Materials and Methods and Electrical Identification."
- H. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.
- I. Ground equipment according to Division 16 Section "Grounding and Bonding."
- J. Connect wiring according to Division 16 Section "Conductors and Cables."

### 3.2 FIELD QUALITY CONTROL

#### A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

#### B. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

**END OF SECTION**

## SECTION 16721

### FIRE ALARM AND DETECTION SYSTEM

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Divisions 1.
- B. Mechanical and Electrical General Requirements Section.
- C. Basic Materials and Methods (Electrical) Section.

##### 1.2 DESCRIPTION OF WORK

- A. Extent of fire alarm and detection system work is indicated by drawings and schedules, and requirements of this section and other Division 16 sections.
- B. Furnish and install a complete Fire Alarm System throughout new and existing building, as described herein; to be wired, connected, and left in first class operating condition. The system shall use closed loop initiating device circuits with individual zone supervision, individual indicating appliance circuit supervision, and incoming and standby power supervision. Include a control panel, manual pull stations, automatic fire detectors, horns, flashing lights, annunciator, all wiring, connections to devices, outlet boxes, junction boxes, and all other necessary material for a complete operating system.
- C. The fire alarm control panel shall allow for loading or editing any special instructions or operating sequences as required. No special tools, modems, or an off-board programmer shall be required to program the system so as to facilitate ease of expansion, building parameter changes or changes as required by local codes. All instructions shall be stored in a resident non-volatile programmable memory.

##### 1.3 QUALITY ASSURANCE

- A. Manufacturers - Firms regularly engaged in manufacture of fire alarm and detection systems, of types, sizes, and electrical characteristics required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer - Qualified with at least 5 years of successful installation experience on projects with fire alarm and detection system installation work similar to that required for project and licensed in the State to sell, install and service fire alarm systems.
- C. NFPA Compliance - Comply with all NFPA requirements for fire alarm and detection systems, components and accessories.
- D. Each and all items of the Fire Alarm System shall be listed as a product of a SINGLE fire alarm system manufacturer under the appropriate category by the Underwriters' Laboratories, Inc. (UL), and shall bear the "U.L." label. All control equipment shall be listed under UL category UOJZ as a single control unit. Partial listing shall NOT be acceptable.

- E. FM Compliance - Provide fire alarm and detection systems and accessories which are FM approved.
- F. Fire Code: Comply with all Code requirements, as adopted and ammended by Local Code Authority.
- G. In addition to the UL-UOJZ requirement listed above, the system controls shall be UL listed for Power Limited Applications per NEC 760. All circuits must be marked in accordance with NEC article 760-23.
- H. All panels and peripheral devices shall be the standard product of a single manufacturer and shall display the manufacturer's name on each component. The catalogue numbers specified under this section are those of the Simplex Time Recorder Company and constitute the type, quality of design, material, and operating features desired.
- I. All components must meet ADA requirements.

#### 1.4 SUBMITTALS

- A. Product Data - Submit manufacturer's data on fire alarm and detection systems including, but not limited to, roughing-in diagrams and instructions for installation, operation and maintenance, suitable for inclusion in maintenance manuals. Also include standard or typical riser and wiring diagrams.

Additionally, equipment submissions must include the following:

1. Complete descriptive data indicating UL listing for all system components.
2. Complete sequence of operations of the system.
3. Complete system wiring diagrams for components capable of being connected to the system and interfaces to equipment supplied by others.

#### 1.5 SHOP DRAWINGS

- A. Provide shop drawings showing equipment/device locations and connecting wiring of entire fire alarm and detection system. Indicate compliance with NFPA 72 E detector location requirements.
- B. Shop drawings shall be submitted to and be approved by the local fire department prior to submittal for formal approval.

#### 1.6 CODES AND STANDARDS

- A. Local Building Code.
- D. NECA Publication A-2-B3 "Fire Alarm Systems" (prepared by NEMA).
- E. NEMA Publication No. SB 4-1971 "Training Manual for Local Fire Protective Signalling Systems".
- F. NFPA Series 72 Pamphlets.
- G. NFPA 101 Life Safety Code.

H. UL Fire Protection Equipment List.

I. Local Fire Codes.

J. ADA

K. TAS

## 1.7 SERVICE

A. Service shall be provided within 24 hours from notice that a fault with the system does exist. The contractor shall include inspections within the first year after acceptance to verify proper operation of the system in strict accordance with NFPA 72H and shall provide written notification to the owner of this schedule.

B. System manufacturer shall have factory trained local area representative.

## PART 2 - PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS:

A. General: It is the intent of these specifications to provide standards for quality and appearance of fire alarm equipment on this project. These standards are given through the indication of specific model numbers of items produced by certain manufacturers. Other manufacturers may make comparable products that will be suitable for use on this project. It is not possible, however, to be completely familiar with each and every product produced today. Therefore, certain manufacturers are listed below who produce, in general, acceptable products.

B. Manufacturers: Any proposed substitutions will be considered only during the bid period. .

### 2.3 FIRE ALARM CONTROL PANEL

A. Provide a Fire Alarm Control Panel with addressable devices. Construction shall be modular with solid state, microprocessor based electronics. All visual indicators shall be high contrast, LED type.

B. The panel shall be of plug-in modular construction with components housed in an enclosure, with locked door, facilitating access to various system control switches. All annunciation shall be visible without opening door. Construction shall be dead front. Provide tumbler lock with 3 keys. The control unit shall include, but not be limited to, the following components required to perform the system operations:

1. Initiating and indicating alarm and trouble zone modules as required for indicated initial zoning plus 4 spares. Zone modules shall include the associated alarm and trouble lamps with zone lettered nameplate designation or function descriptions adjacent to each lamp.

2. Modules required for double supervision. Style D, Class A (four-wire with end of line resistor located in Fire Alarm Control Panel) supervision of both alarm initiation and alarm signalling circuits.
3. Supervisory audible signal and silencing switch with re-ring.
4. Modules required for supervision of annunciator.
5. Remote signal transmission - the control panel shall be equipped with a digital central station transmitter (SDACT) for point reporting. The owner will arrange for this connection and the required telephone lines. Coordinate all requirements with the base fire department.

C. Provide the following additional features:

- 8 Initiation Device Circuits (plus spares)
- 2 Alarm Indicating Appliance Circuit
- 8 Supervised Annunciator Circuits (plus spares)
- 1 (selectable) Local Energy, Shunt Master Box, or Reverse Polarity Remote Station Connection
- 2 Form C Alarm Contacts (2.0 Amps ea.)
- 1 Form C Trouble Contact (2.0 Amps ea.)
- 1 Earth Ground Supervision Circuit
- 1 Automatic Battery Charger
- (2) 12 Ah Standby Batteries
- 1 lot Resident non-volatile programmable operating system memory for all operating requirements.
- 1 Supervised Manual Evacuation Switch
- contacts for access control system inter-connection
- contacts for security system inter-connection

Verify and provide final quantities of devices and modules as necessary to meet the full requirements of the complete system, as indicated in plans, specifications, and requirements of local authority having jurisdiction.

## 2.4 PERIPHERAL DEVICES

- A. Provide double action type manual pull stations with back box.. To minimize nuisance alarms, activation shall require two separate and distinct actions. Reset shall require a key common to the control panel. Pull station shall be by the same manufacturer to insure compatibility.
- B. Furnish and install complete coverage and where indicated or required, addressable smoke detectors. Detectors shall be listed to U.L. standard 268 and shall be documented compatible with the control equipment to which it is connected. Detectors shall be listed for this purpose by Underwriters Laboratories Inc. The detectors shall obtain their operating power from the fire alarm panel supervised detection loop. The operating voltage shall be 24VDC (nominal). Removal of the detector head shall interrupt the supervisory circuit of the fire alarm detection loop and cause a trouble signal to be generated at the control panel.

Each detector shall have a flashing status indicating LED for visual supervision. When the detector is actuated, the flashing LED will latch on steady and at full brilliance. The detector may be reset by actuating the control panel reset switch.

To minimize nuisance alarms, voltage and RF transient suppression techniques shall be employed as-well-as a smoke verification circuit and an insect screen. The detector design shall provide full solid-state construction and compatibility with other normally open fire alarm detection loop devices, (heat detectors, pull stations, etc.). The detector head shall be easily disassembled to facilitate cleaning.

C. Horns

The horns shall be polarized and shall be operated by 24 VDC. Each horn assembly shall include separate wire leads for in/out wiring for each leg of the associated signal circuit. T-tapping of signal device conductors to signal circuit conductors shall NOT be accepted. The alarm horns shall be suitable for rear mounting behind audio-visual assemblies which shall be flush mounted. The white lexan lens shall have the word 'FIRE' in red lettering on the sides and shall be pyramidal in shape to allow for side viewing. Comply with UL 1480 speaker output ratings. Provide white housing with red letters.

D. Visual Flashing Lamps (Xenon Strobe)

Visual indicating appliances shall be comprised of a Xenon flashtube and be entirely solid state. These devices shall be UL listed and be capable of either ceiling or wall mounting. The LEXAN lens shall be pyramidal in shape to allow better visibility. Visual units shall be of the stand alone type or be incorporated as part of the Horn unit. Provide 110 candela output. Provide white housing with red letters.

D. Combination Horn-Strobes

Provide combination horn-strobe units meeting the requirements listed above for individual horns and strobes.

E. Duct Smoke Detectors

Duct smoke detectors shall be of the solid state photoelectric type and shall operate on the light scattering photodiode principle. The detectors shall be designed to ignore invisible airborne particles or smoke densities that are below the factory set alarm point. No radioactive materials shall be used. Detector construction shall be of the split type, that is, mounting base with twist-lock detecting head. Contacts between the base and head shall be of the bifurcated type using spring-type, self-wiping contacts. Removal of the detector head shall interrupt the supervisory circuit of the fire alarm detection loop and cause a trouble signal at the control panel. Detector design shall provide full solid state construction and compatibility with other normally open fire alarm detection loop devices, (heat detectors), (pull stations, etc.). Duct housing couplings shall be slotted to insure proper alignment of the sampling and exhaust tubes. Detector shall have an alarm LED visible through a transparent front cover. Detectors shall obtain their operating power from the supervised current in the fire alarm loop. Installation must comply with NFPA-90A. Provide to mechanical contractor for installation in ductwork.

2.5 ZONING:

In addition to any zones required by NFPA, provide zones as follows, unless indicated differently on the plans:

- A. Air Handling Units: The smoke and heat detectors associated with each separate air unit shall constitute an alarm initiating zone.

- B. Manual Pull Stations: Provide an annunciation circuit for manual pull stations.
- C. Equipment Rooms: The manual and automatic alarm initiation devices located in the mechanical and electrical equipment room (exclusive of those specified to constitute separate zones) shall constitute a separate alarm initiation zone.
- D. All other alarm signaling devices shall constitute an alarm indicating zone or zones as required.

## 2.6 RESET

It shall be possible for authorized personnel (with a special key) to reset the alarm system at the previously triggered initiating device or fire alarm panel, and cancel the alarm condition.

## 2.7 POWER SUPPLY

- A. The control panel shall receive 120 VAC power (as noted on the plans) via a dedicated circuit.
- B. The system shall be provided with sufficient battery capacity to operate the entire system upon loss of normal 120 VAC power in a normal supervisory mode for a period of (24) twenty-four hours with five (5) minutes of both audible and visual alarm indication at the end of this period. The system shall automatically transfer to the standby batteries upon power failure. All battery charging and recharging operations shall be automatic. Batteries, once discharged, shall recharge at a rate to provide a minimum of 70% capacity within 12 hours.
- C. All circuits requiring system operating power shall be 24 VDC and shall be individually fused at the control panel.

## 2.8 COORDINATION WITH OTHER TRADES

- A. General: coordinate with Mechanical, Sprinkler, Security, Electrical, and Access Control trades as necessary, as required for complete operation, and as indicated on plans..
- B. Incorporate sprinkler system supervision devices, specified in the fire protection section, in the fire alarm system. Coordinate system requirements and do not duplicate.

## 2.9 SYSTEM OPERATION

- A. The system alarm operation subsequent to the alarm activation of any manual station, automatic detection device, or sprinkler flow switch shall be as follows:
  1. The appropriate initiating device circuit red LED shall flash on the control panel until the alarm has been silenced at the control panel]. Once silenced, this same LED shall latch on. A subsequent alarm received after silencing shall flash the subsequent zone alarm LED on the control panel.
  2. A pulsing alarm tone shall occur within the control panel until silenced.
  3. All alarm indicating appliances shall sound in a Temporal Code pattern until silenced by the Alarm Silence Switch at the control panel or the remote annunciator.

4. All visual alarm lamps [Xenon Strobes] shall operate in a [Temporal Code] pattern until:

Extinguished by the Alarm Silence Switch

Operate all strobes in a synchronized pattern between floors, such that all strobes, regardless of location, flash in unison, per ADA requirements.

5. The audible alarms shall automatically time out and switch off after ten (10) minutes of alarm operation.
  6. Transmit alarm to a central station .
  7. Indicate location of alarm source on the control panel.
- C. The actuation of the program "Test Set-up" switch at the control panel shall activate the "Walk Test" mode of the system which shall cause the following to occur:
1. The reporting circuit shall be disconnected.
  2. Control relay functions shall be bypassed.
  3. The control panel shall show a trouble condition.
  4. The alarm activation of any initiation device shall cause the audible signals to pulse one round of code identifying the initiation circuit (e.g.: an activated smoke detector connected to Zone 4 shall pulse the audible signals 4 times in rapid succession).
  5. The panel shall automatically reset itself.
  6. Any momentary opening of an initiating or indicating appliance circuit shall cause the audible signals to sound for 4 seconds to indicate the trouble condition.
- D. A manual evacuation switch shall be provided to operate the systems indicating appliances or initiate "Drill" procedures.
- E. Activation of an auxiliary bypass switch shall override the automatic functions either selectively or throughout the system and initiate a trouble condition at the control panel.

## 2.10 SUPERVISION

- A. The system shall contain Style 'D', Class 'A' independently supervised initiation circuits so that a fault in any one zone shall not affect any other zone. The alarm activation of any initiation circuit shall not prevent the subsequent alarm operation of any other initiation circuit. Provide circuits and modules sufficient for complete operation plus spare capacity.
- B. Provide two independently supervised and independently fused indicating appliance circuits for alarm horns and flashing alarm lamps.
- C. Supervise all auxiliary manual controls so that all switches must be returned to the normal automatic position to clear system trouble.

- D. For each independently supervised circuit, include a discrete amber "Trouble" LED to indicate disarrangement conditions per circuit.
- E. Supervise the incoming power to the system so that any power failure shall be audibly and visually indicated at the control panel [and the annunciator]. A green "power on" LED shall be displayed continuously while incoming power is present.
- F. The system batteries shall be supervised so that disconnection of a battery shall be audibly and visually indicated at the control panel and the annunciator.
- G. The System Expansion Modules connected by ribbon cables shall be supervised for module placement. Should a module become disconnected from the C.P.U. the system trouble indicator shall illuminate and audible trouble signal shall sound.
- H. Provide one supervisory initiation circuit for connection of all sprinkler valve tamper switches to perform the operation listed for 1.4.E. Wiring methods which affect any fire alarm initiation circuits to perform this function shall be deemed unacceptable; i.e.: sprinkler and standpipe tamper switches (N/C contacts) shall NOT be connected to circuits with fire alarm initiation devices (N/O contacts). This independent initiation circuit shall be labeled "Sprinkler Supervisory Tamper" and shall differentiate between tamper switch activation and wiring faults.

### **PART 3 - EXECUTION**

#### **3.1 MANUFACTURER'S DIRECTIONS**

Install systems in strict accordance with manufacturer's recommendations and requirements of other sections.

#### **3.2 WIRING**

- A. Wire size and installation shall be in accordance with manufacturer's recommendations and shall be installed under the supervision of a factory trained representative of the fire alarm equipment manufacturer.
- B. Control and other panels shall be mounted with sufficient clearance for observation and testing. Fire alarm junction boxes shall be clearly marked for distinct identification. Wiring shall be in conduit. Flexible conduits, mounting boxes, junction boxes and panels shall be securely fastened with appropriate fittings to insure positive grounding throughout the entire system. Entire raceway system shall be grounded.
- C. No wiring other than detector and alarm circuits are permitted in fire alarm conduits. Wire shall be color coded, minimum 12 gauge TW, 600 volt insulation for AC circuits, 16 gauge for alarm signalling circuits, and 16 gauge for alarm initiation circuits. Transposing or changing color coding of wires is not permitted.
- D. Wiring shall be completely installed, field connections made and tested for voltage and stray signals before final connections to control panel terminals are made. Wires shall terminate on identified terminal strips. Wire splices are unacceptable. Wires shall be identified on each end by wire number with permanent wire markers. Use bare wire connections where connections are made to tube-clamp terminals. Use lug type Sta-Kon wire connectors, sized to fit both the wire and terminal, where wires are connected to screw terminals. Wiring shall be checked and

tested to insure that there are no grounds, opens or shorts. This test shall be made after all conduit, wire, detector bases, and the like are installed, but before detectors are installed.

- E. Spray paint all junction boxes red and label "Fire Alarm" in white.

### 3.3 COORDINATION

Installation of equipment and devices that pertain to other work in the contract shall be closely coordinated with the appropriate subcontractors. Coordinate work with telecomm company for remote monitoring. Coordinate installation of phone lines for certified operation of system, per NFPA requirements. Advise Owner of schedule and recommended time for installation of phone lines for DACT.

### 3.4 CLEANING

The contractor shall clean all dirt and debris from the inside and the outside of the fire alarm equipment after completion of installation.

### 3.5 SUPERVISION

The manufacturer's authorized representative shall provide onsite supervision of installation.

### 3.6 DEMONSTRATION

- A. Upon completion of the installation and after preliminary testing, a factory certified technician shall install the detectors, and perform the necessary tests and adjustments to the system. The technician shall calibrate and adjust all detectors in place and under operating conditions, and shall submit three copies of a written report on forms provided by the manufacturer to indicate the system has been fully tested in supervision, trouble and alarm modes, and is fully operational, conforming to the letter of these specifications.
- B. The test report shall contain, but is not limited to:
  - 1. A complete list of equipment installed and wired.
  - 2. Indication that all equipment is properly installed.
  - 3. Tests of individual zones as applicable.
  - 4. Serial numbers, locations by zone, and model number of each installed detector.
  - 5. Voltage (sensitivity) settings for each ionization detector, as measured in place with the air conditioning system operating.
  - 6. Response time on automatic alarm initiating devices.

### 3.7 AS-BUILT DOCUMENTATION

After completion of all of the tests and adjustments listed above, submit:

As-built conduit layout diagrams, including wire color code and/or tag number.

Complete as-built wiring diagrams.

Detailed catalog data on all installed system components.

Copies of the technician's certified report (as above).

### 3.8 OPERATOR TRAINING

One hour of instruction shall be provided to maintenance and staff personnel detailing operational and maintenance aspects of the system. Three complete sets of as-built drawings shall be delivered to the Owner upon acceptance of the system.

### 3.9 WARRANTY

- A. The contractor shall warrant the completed fire alarm system wiring and equipment to be free from inherent mechanical and electrical defects for a period of one (1) year from the date of the completed and certified test or from the date of first beneficial use.
- B. The equipment manufacturer shall make available to the owner a maintenance contract proposal to provide a minimum of two (2) inspections and tests per year in compliance with NFPA-72H guidelines.

**END OF SECTION**